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H7C27

INFLUENCE OF 500-kV LINES ON CBL-CJBC COVERAGE PROGRESS REPORT NO 3

R.C. Madge

Field strength measurements of the patterns of the CBL/CJBC radio broadcast antenna at Hornby at 80 test points after construction of the second Milton TS-Claireville TS 500-kV line have been made. A comparison with measurements taken before construction of this line shows measurable differences, attributable to the line, to construction of new structures near the test points, to locally changing ground conductivity, and to operator error. Due to the nature and magnitude of the last three contributors it is impossible to determine the contribution from the transmission line; however, it is expected to be relatively small.

The second Milton TS-Claireville TS 500 kV line has been completed. It passes within 453 metres of the CBL/CJBC two-frequency radio broadcast antenna at Hornby. In order to try to determine the effect this line will have on the radio station, pattern measurements on a 16 km circle were taken before construction of the towers, (November 1981), after erection of the towers (April 1982) and just recently after completion of the line complete with conductors (October 1982). Two existing lines occupy the same corridor past the antenna and numerous field strength measurements have been taken in the past concerning those lines. Table 1 summarizes the past field strength tests.

FIELD MEASUREMENTS

Tony Caruso of the CBC, Gordon Elder, Broadcast Consultant for the CBC, Tony Van Schyndel of the Department of Communications, and Rick Madge of Ontario Hydro, took part in these measurements. Field

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strength readings were taken at 80 test points for each of the CBC frequencies, 740 kHz and 860 kHz. These readings constitute the eighth set of readings concerning the CBC antenna patterns. For reasons explained in the first progress report/1/, and amplified later in this report, the first four sets of measurements are deemed to be invalid for close analysis.

TABLE 1

Test No	Transmission Line Condition	Date
1	No Power Lines	October, 1976
2	Towers only - First Two Lines	June, 1977
3	Both Lines Complete	October, 1977
4	Skywire Isolated On Selected Towers of Both Lines	November, 1977
5	Identical to No 4. Coverage tests at distant locations using different test points	July, 1978
6	Identical to No 4	November, 1981
7	Towers of 2nd Milton TS-Claireville TS 500 kV Line Erected	April, 1982
8	2nd Milton TS-Claireville TS 500 kV Line Complete	October, 1982

ANALYSIS OF RESULTS

The analysis will be limited to a comparison of Test No 8 with Test No 6 only. The analysis was carried out as follows:

1. Using the CBC antenna current and antenna impedance, each reading is adjusted for exactly 50 kW output. This cancels out any CBC antenna variations from one test to the next.

2. During the testing, test points were labelled as "BAD POINTS", "QUESTIONABLE POINTS", or "ACCEPTABLE POINTS". The reasons a test point would be labelled as BAD or QUESTIONABLE were varied. It was agreed by the group that the BAD POINTS would be included as data, but left out of all analyses and the QUESTIONABLE POINTS would be included but indicated in all analyses.

3. At each test point, four measurements were taken by different operators using different meters. The average value of the readings at each test point is calculated.

4. The average value of the 80 test points is calculated. To cancel changes in the ground conductivity over the whole area, this average is scaled to a common number (equal to the average from Test No 1). The average value at each test point is then multiplied by the scaling factor. Some discussion of this overall ground conductivity scaling factor will follow.

5. A ratio is created at each test point for the Test No 8 value to the Test No 6 value.

DISCUSSION OF RESULTS

Figures 1 and 2 represent the ratios of Test No 8 values to Test No 6 values for CBL, 740 kHz, and CJBC, 860 kHz, respectively. For CBL, seven test points show greater than 10% variation with a maximum positive difference of 15% and a maximum negative difference of 21%. For CJBC, 13 test points show greater than 10% variation with maximum positive and negative differences of 20% and 19% respectively. These differences can be attributed to the new transmission line, to locally changing ground conductivities, to construction of new structures near test points and to operator error. Construction of new structures both near test points and between the antenna and the test point can cause significant variations. From here on, the term "new construction" will mean both types.

Figures 3 and 4 represent the ratios of Test No 6 values to Test No 4 values at 740 kHz and 860 kHz respectively. Test No 4, taken November 1977, and Test No 6, taken November 1981, had identical transmission line conditions. That is, no new lines were built near the CBC antenna in those 4 years. (Four test point locations had changed due to inaccessibility at the time of Test No 6 and these were left out of the analyses). All differences can therefore be attributed to locally changing ground conductivity, new construction and operator error. As stated in the first progress report/1/, the operator error in the first four tests is unacceptably high. However, even taking that into account, we see very large variations in Figures 3 and 4 that must be attributed to local ground conductivity changes and new construction. For CBL, 23 test points show greater than 10% variation with maximum positive and negative differences of 24% and 15% respectively. For CJBC, 25 test points show greater than 10% variation with maximum positive and negative differences of 24% and 22% respectively. These differences are far greater than those seen with the introduction of the second Milton TS-Claireville TS 500 kV line.

Table 2 illustrates further examples of large signal variations. The overall test average (corrected to 50 kW antenna output) for each test is normalized to a reference value. This is an attempt to cancel out variations in ground conductivity over the whole area. These variations, seen in Table 2, are measured in the field and are factored out for analysis. Between Test No 1 and Test No 7 there is a 17.% drop in average signal level for CBL and 17.1% for CJBC. This hidden difference, affecting listener signal levels,

has a larger magnitude than we see in Figures 1 and 2. The loss in signal cannot be attributed solely to the transmission lines as the variations between identical transmission line tests, Test No 6 and Test No 4, are 9.6% and 9.4% for CBL and CJBC respectively.

As we can see in Figures 1 and 2 the variations are small when compared with potential variations seen in Figures 3 and 4, and in hidden overall ground conductivity changes. It is impossible to quantify the contribution of the new transmission line to these variations. In view of the magnitude of variation, potential and real, of other factors, the new transmission line can be considered to have a relatively small effect on the patterns of the CBL and CJBC.

TABLE 2

OVERALL TEST AVERAGE SIGNAL LEVEL
(CORRECTED TO 50 kW)

TEST NO	DATE OF TEST	CBL	CJBC
1	October, 1976	112.8 mV/m	115.7 mV/m
2	June, 1977	110.2 mV/m	107.4 mV/m
3	October, 1977	115.1 mV/m	110.9 mV/m
4	November, 1977	109.1 mV/m	112.3 mV/m
6	November, 1981	98.6 mV/m	101.7 mV/m
7	April, 1982	93.1 mV/m	95.9 mV/m
8	October, 1982	103.1 mV/m	95.1 mV/m

DISCUSSION OF OPERATOR ERROR

We felt it was important to identify the calculated operator errors for CBL and CJBC for all the tests. The method of calculation is listed in Appendix A.

The resulting figures were put in Table 3. The column for each frequency marked 'Spread' represents the limits of operator error from maximum negative variation to maximum positive variation.

Table 3 illustrates that, with the exception of Test Nos 2 and 3, all the standard deviation values are fairly small. This means that, on the average, the operator errors are small. However, analysis of field strength ratios considers every individual ratio. Since each test point covers 4-5° of azimuth, we cannot afford to have any bad readings. The spread therefore is a better indication of the reliability of the readings. We see spreads for Test Nos 2 and 3 outrageously high. These tests should be discounted entirely. The spreads for Test Nos 1 and 4 are typically 6-13% higher than for Test Nos 6, 7 and 8. This added uncertainty is unacceptably high.

TABLE 3

TEST #	METER	CBL - 740 kHz				CJBC - 860 kHz			
		STANDARD DEVIATION %	VARIATION			STANDARD DEVIATION %	VARIATION		
			MAX+ %	MAX- %	SPREAD %		MAX+ %	MAX- %	SPREAD %
1	CBC 1	3.4	8.0	-8.8	16.8	3.1	7.7	-10.4	18.1
	CBC 2	3.0	6.7	-5.3	12.0	3.2	10.1	- 6.0	16.1
	CBC 3	2.9	6.2	-12.7	18.9	2.1	3.3	- 7.9	11.2
2	CBC 1	6.2	45.1	-12.9	58.0	6.5	44.5	-21.1	65.6
	CBC 3	5.3	11.1	-38.8	49.9	5.6	18.2	-38.5	56.7
3	CBC 1	5.3	12.1	-13.1	25.2	5.1	14.4	-15.7	30.1
	CBC 2	3.9	13.2	-11.7	24.9	4.0	10.4	- 7.2	17.6
	CBC 3	4.0	9.3	-10.2	19.5	3.5	8.2	- 7.7	15.9
4	CBC 1	3.8	12.8	-10.9	23.7	3.5	11.5	-10.1	21.6
	CBC 2	2.7	6.3	- 6.0	12.3	2.4	8.0	- 6.1	14.1
	CBC 3	3.2	10.4	- 9.1	19.5	2.8	7.2	- 6.6	13.8
6	OH	1.3	4.2	- 3.7	7.9	1.1	3.5	- 2.2	5.7
	Cons	1.3	3.7	- 4.2	7.9	1.1	2.2	- 3.5	5.7
7	OH	1.3	2.4	- 3.2	5.6	1.3	2.9	- 3.2	6.1
	Cons	1.4	3.0	- 3.5	6.5	1.3	2.8	- 3.2	6.0
	CBC	1.7	4.7	- 3.4	8.1	2.4	6.4	- 3.4	9.8
	DOC	1.9	3.9	- 4.4	8.3	2.3	5.6	- 6.7	12.3
8	OH	1.1	4.5	- 2.2	6.7	1.2	5.9	- 3.0	8.9
	Cons	1.7	3.8	- 5.3	9.1	1.5	4.4	- 3.4	7.8
	CBC	1.5	4.0	- 4.0	8.0	1.5	5.3	- 4.6	9.9
	DOC	1.3	2.8	- 3.9	6.7	1.6	3.4	- 5.2	8.6

We felt it was necessary to graphically demonstrate the effects of operator error on analysis. Figures 5 and 6 represent the distortion introduced by operator error, and were arrived at in the following way.

1.) The best two meters for Tests 1, 4, 6 and 8 were found from Table 3 and are listed below:

Test 1	Meters CBC 2 and CBC 3
Test 4	Meters CBC 2 and CBC 3
Test 6	Meters OH and Cons
Test 8	Meters OH and DOC

2.) The analysis, as outlined in Analysis of Results earlier in this report, was repeated using only one meter at a time.

3.) Four after-to-before ratios were calculated. These are:

RATIO SET A - Test #4 [CBC 2 meter] to Test #1 [CBC 2 meter]
RATIO SET B - Test #4 [CBC 3 meter] to Test #1 [CBC 3 meter]
RATIO SET C - Test #8 [OH meter] to Test #6 [OH meter]
RATIO SET D - Test #8 [DOC meter] to Test #6 [Cons meter]

Each ratio set represents the results we would have if only one meter had been sent out on the field strength tests. Ideally, Ratios Sets A and B, and Ratio Sets C and D should be identical. However, operator error will introduce variations. All other differences (such as calibration differences between meters) are factored out.

The upper graph in Figure 5 represents the ratios of Ratio Set B to Ratio Set A for CBL. The lower graph represents the ratios of Ratio Set D to Ratio Set C for CBL. Figure 6 represents the same curves for CJBC.

If no operator error existed then the curves would be straight lines as the respective Ratio Sets would be identical. The variations from 1.0 actually reflect differences between the Ratio Sets involved. The magnitude of these differences demonstrates the magnitude of the misinterpretation which could result from operator error. As seen in Figures 5 and 6 the average and maximum differences for the Test #4 to Test #1 ratios far exceed those for Test #8 to Test #6 ratios. As stated in our first progress report/1/, we feel Test Nos 1 and 4 can be used as gross indicators only. The high level of operator error precludes any finer analysis.

CONCLUSION

Test No 8 represents a high confidence level set of readings taken after construction of the second Milton TS-Claireville TS 500 kV line. Variations in the comparison with Test No 6, taken before construction of the line, may be attributed to the new transmission line, locally changing ground conductivity, new construction near test points and between the antenna and test points, and operator

error. Although it can't be shown that the transmission line causes any variation, it is expected that the contribution to the variations by the transmission line is small in relation to the other factors. As well, the overall ground conductivity, although factored out of the analysis, represents a variation of the same order or larger than any contribution from the transmission line.

The high level of operator error in Test Nos 1-4 precludes any fine analysis involving these early tests.

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3. Michel Durocher, "Field Intensity Measurements CBL/CJBC - Toronto (1st Set)". CBC Report ER-193. Feb 1, 1977.

4. Michel Durocher, "Field Intensity Measurements CBL/CJBC - Toronto (2nd Set)". CBC Report ER-203. July 7, 1977.

5. Lise Gauthier, "Field Intensity Measurements CBL/CJBC - Toronto (3rd Set)". CBC Report ER-216. Dec 1, 1977.

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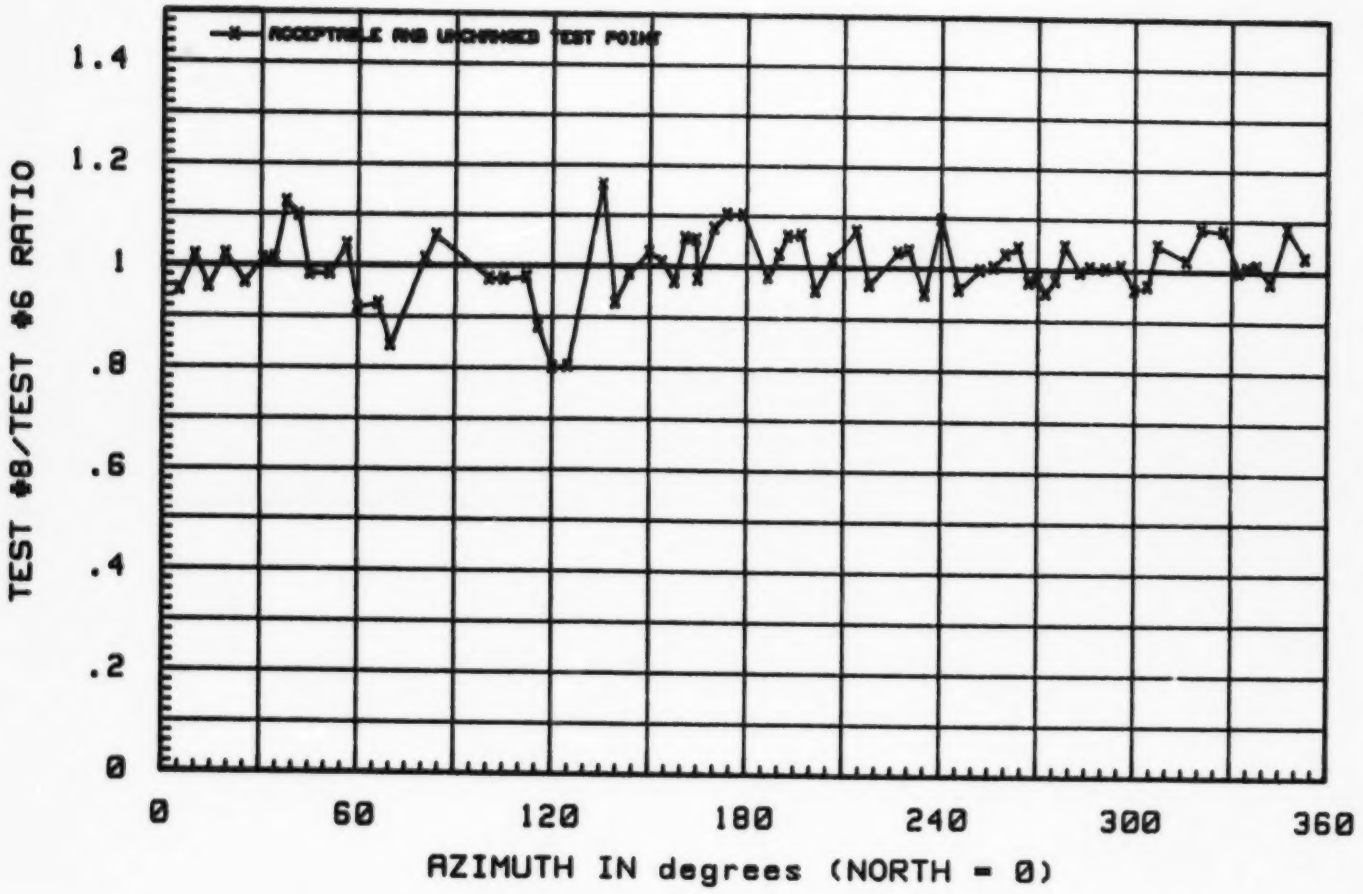
7. Michel Durocher, "Field Intensity Measurements on CBL/CJBC - Toronto (5th Set)". CBC Report ER-261. Feb 6. 1979.

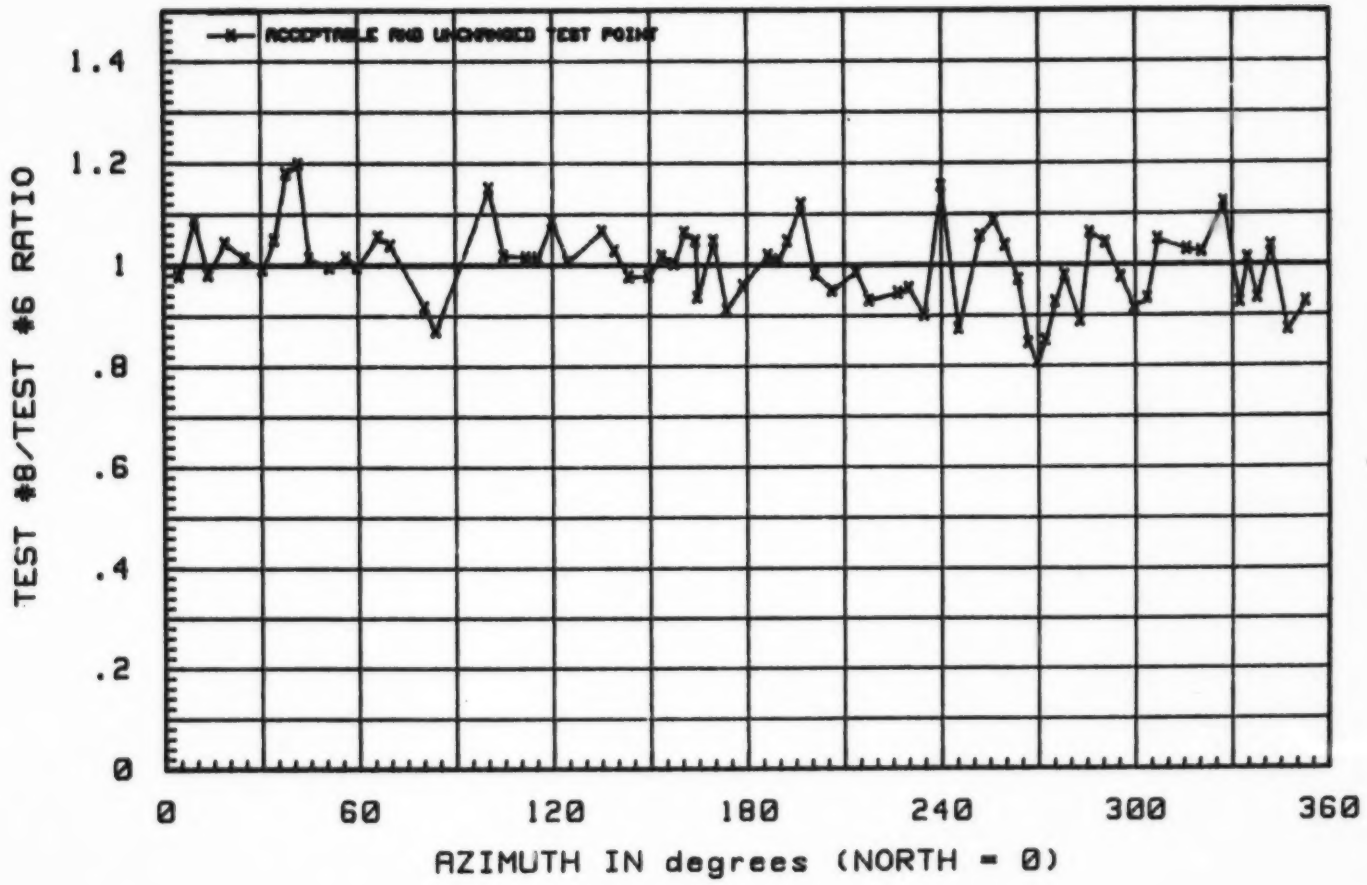
NOTE: References 3-7 were prepared by the CBC on behalf of the three co-operating groups: CBC, Ontario Hydro, Department of Communications.



CBL FIELD STRENGTH MEASUREMENTS

RATIO OF TEST #8 TO TEST #6

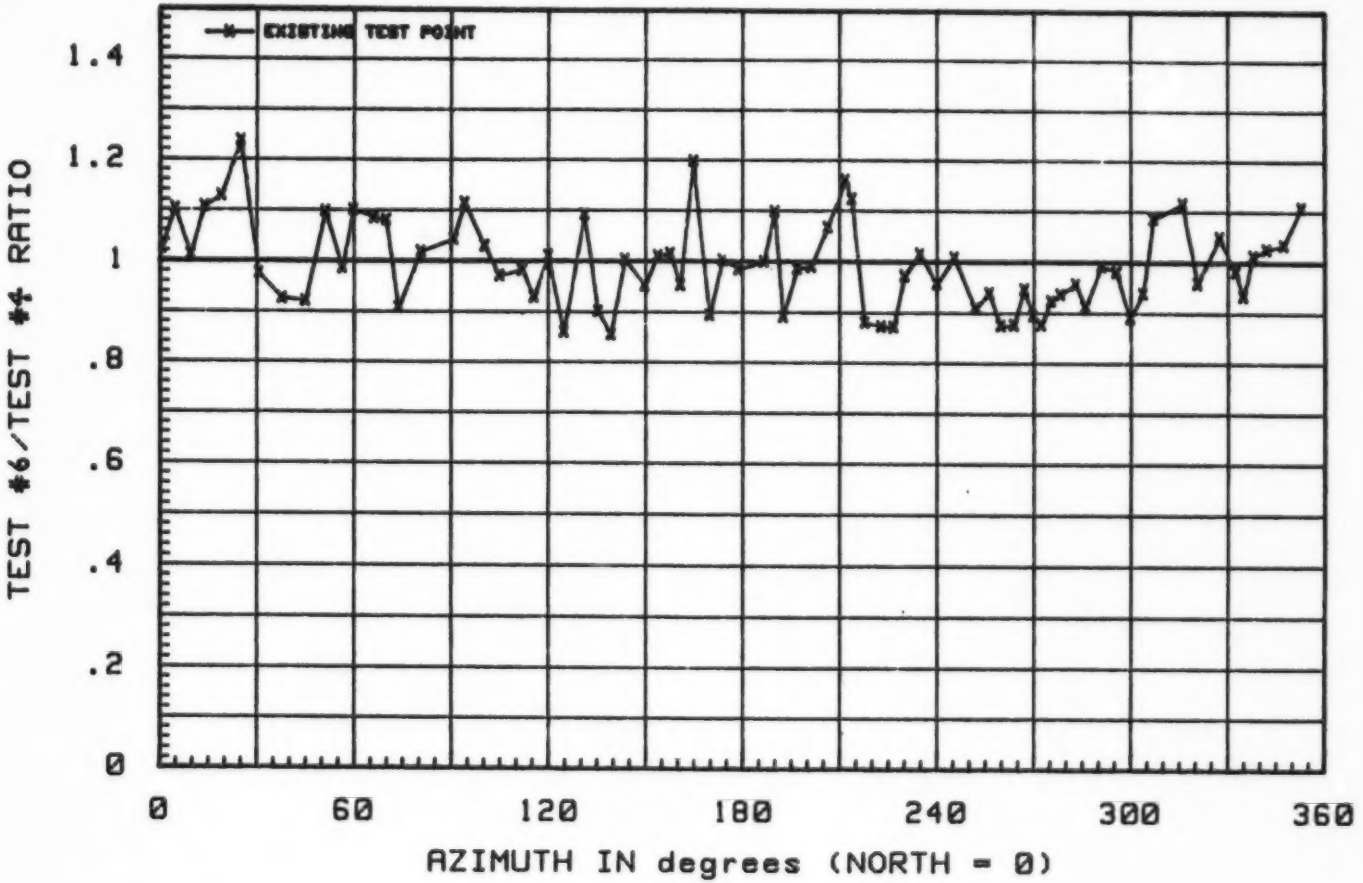
FIGURE 1



CJBC FIELD STRENGTH MEASUREMENTS

RATIO OF TEST #8 TO TEST #6

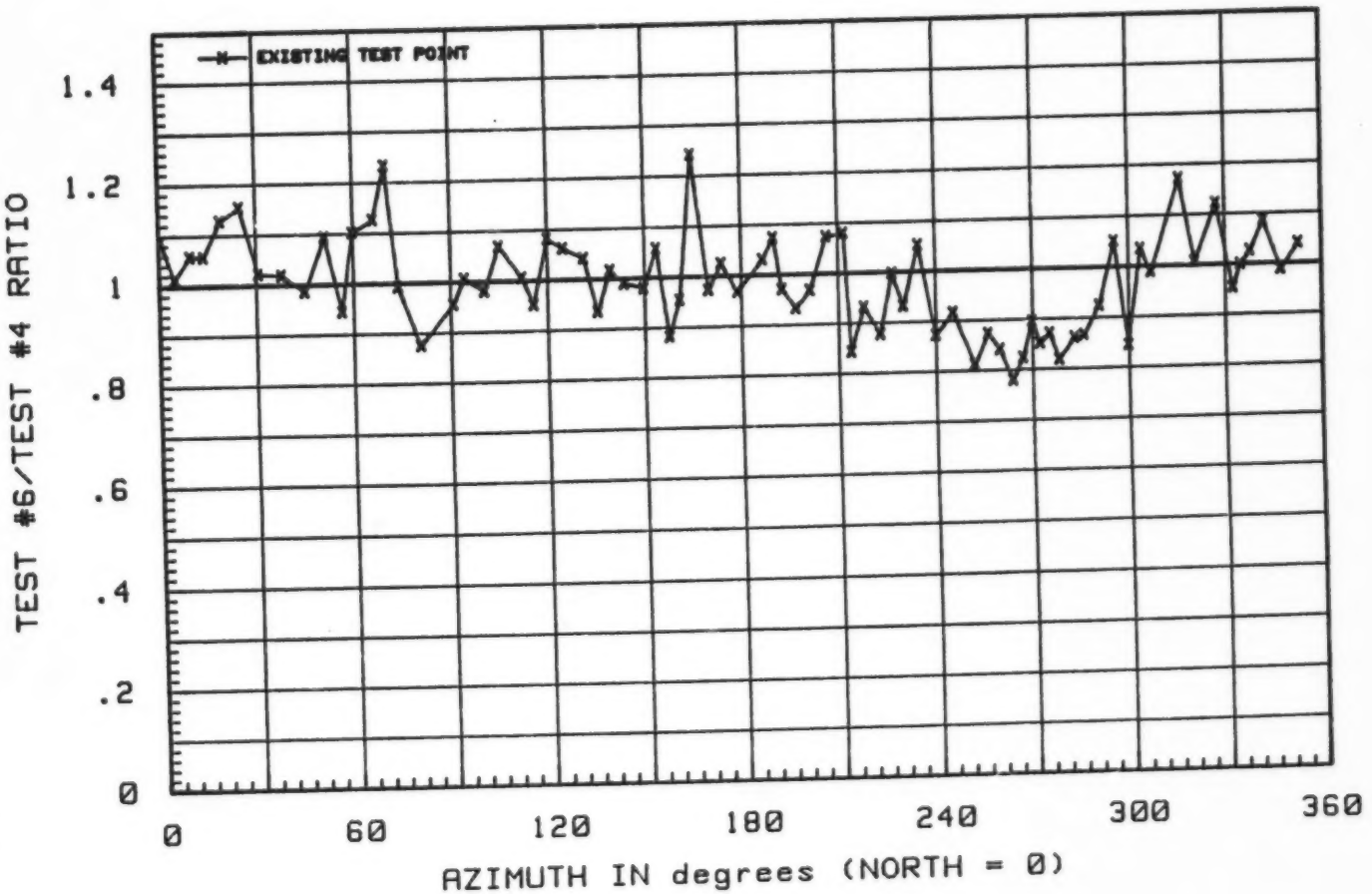
FIGURE 2



CBL FIELD STRENGTH MEASUREMENTS

RATIO OF TEST #6 TO TEST #4

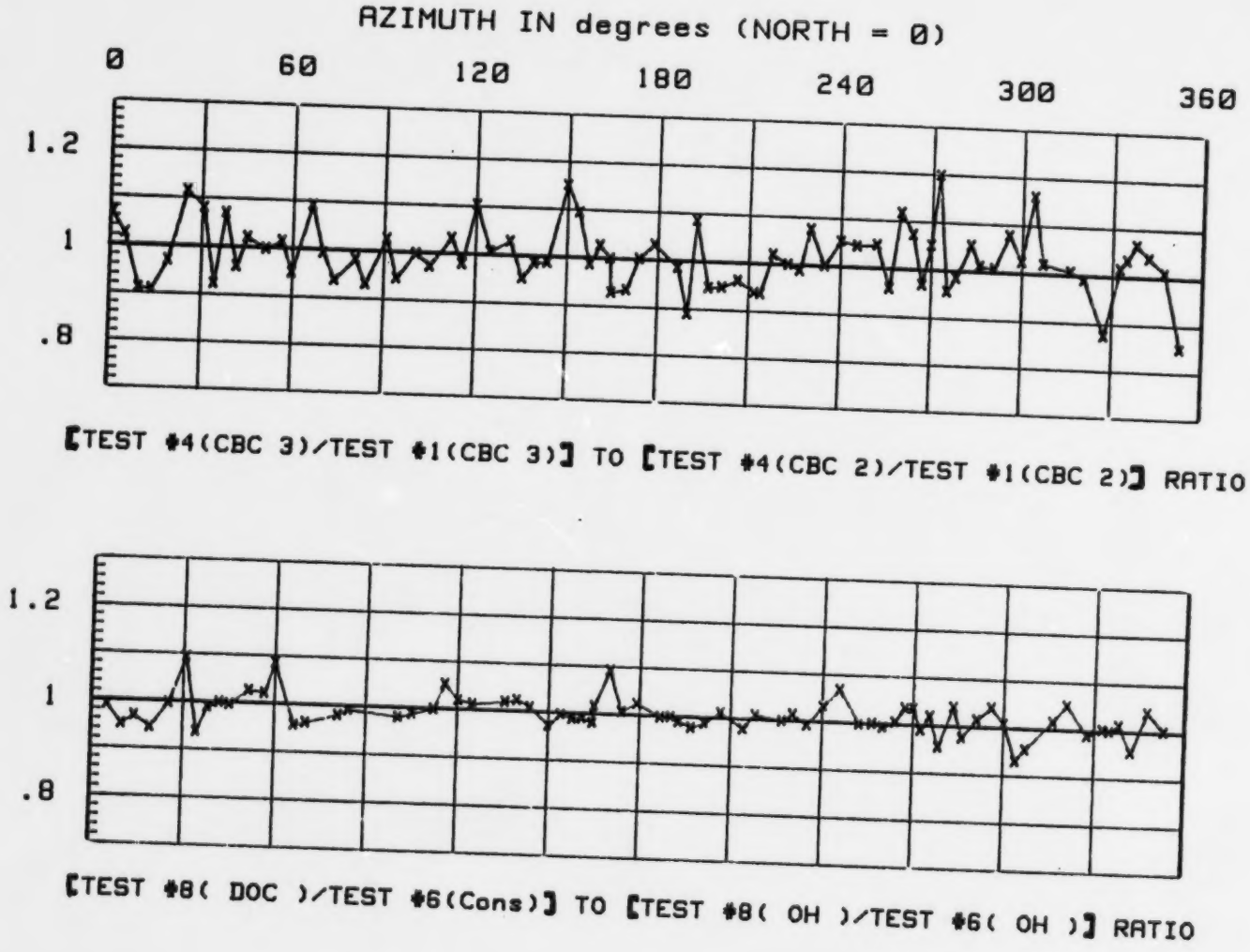
FIGURE 3



CJBC FIELD STRENGTH MEASUREMENTS

RATIO OF TEST #6 TO TEST #4

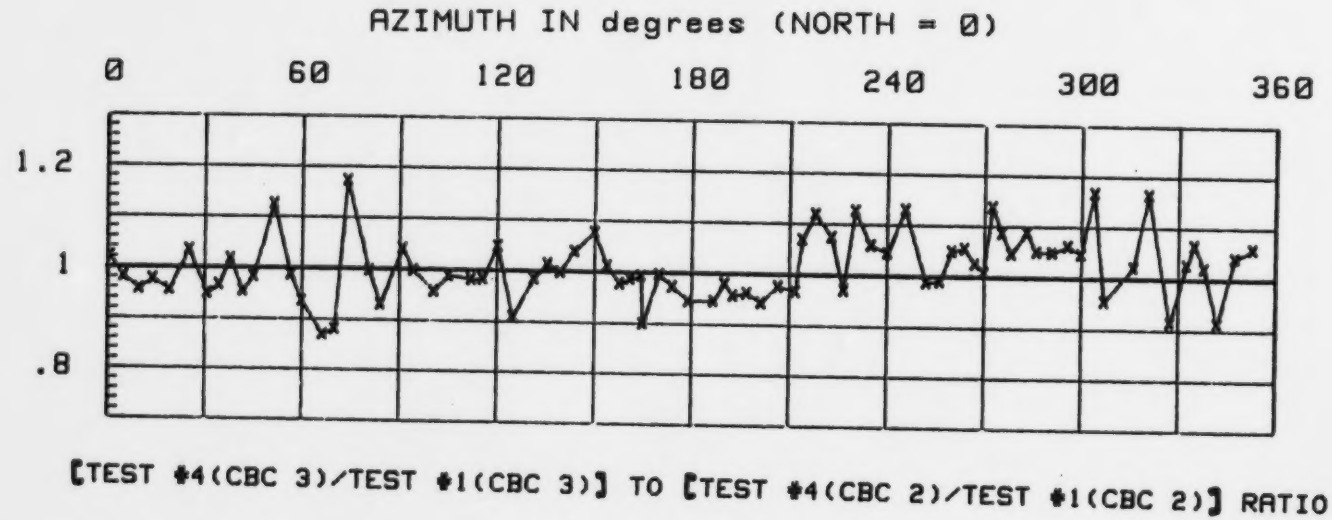
FIGURE 4

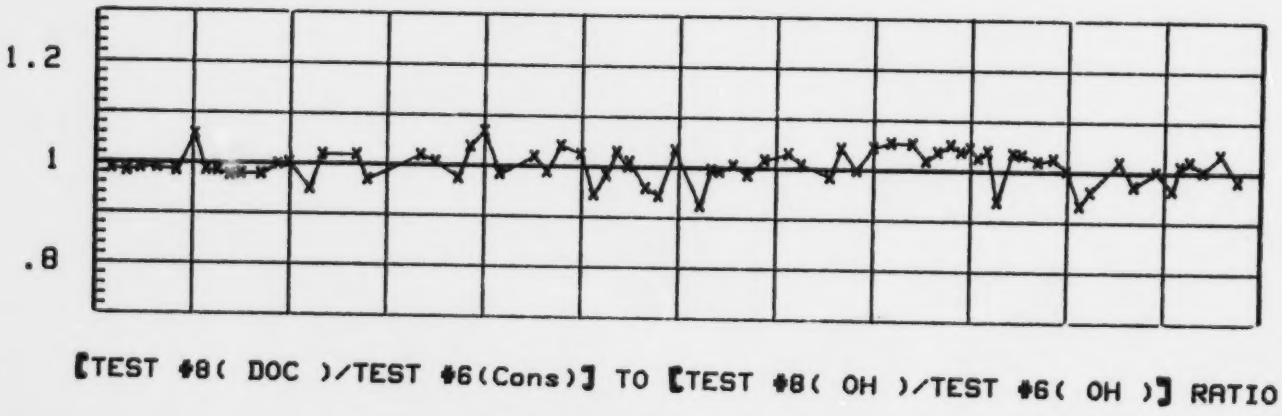


CBL FIELD STRENGTH MEASUREMENTS

COMPARISON OF OPERATOR ERROR

FIGURE 5





CJBC FIELD STRENGTH MEASUREMENTS

COMPARISON OF OPERATOR ERROR

FIGURE 6

APPENDIX A

Method of Calculating Operator Error

The operator error was calculated as follows:

1. The measured values for CBL, Test No 1 were corrected to 50 kW antenna output.

2. The test point average ($\overline{TP}_i$) for each test point was calculated. Each meter average ($\overline{M}_N$) was calculated over all the test points.

3. A factor (F_N) was obtained to cancel meter calibration errors:

$$F_N = \overline{M}_N / \overline{T}$$

where $\overline{T}$ is the average of all test point averages

$$\overline{T} = \frac{\sum_{i=1}^{81} \overline{TP}_i}{81}$$

4. A variation (V_{Ni}) for each meter at each test point was obtained by comparing the actual meter reading (M_{Ni}) to the test point average corrected for the meter calibration. The result was put in percentage form

$$V_{Ni} = \frac{M_{Ni} - \overline{TP}_i * F_N}{\overline{TP}_i * F_N} * 100$$

5. The maximum positive and negative variations were found, and a standard deviation was calculated on the variations

$$SD_N = \sqrt{\frac{\sum_{i=1}^{81} V_{Ni}^2}{80}}$$

6. This process was repeated for CJBC.

7. Steps 1-6 were repeated for Test Nos 2-8.